FLUKE 51,52

K/J Thermometer

Service Manual

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Section 1
Introduction and Specifications

1-1. INTRODUCTION

This manual presents service information for the Fluke 51 and 52 K/J Thermometers. Included are a theory of operation, general maintenance procedures, performance tests, calibration procedures, troubleshooting information, a list of replacement parts, and schematic diagrams.

1-2. OPERATING INSTRUCTIONS

For operating instructions, refer to the Operator's Manual provided with the instrument at the time of purchase, or order Fluke P/N 769026 for the 51 K/J Thermometer Operator's Manual or Fluke P/N 764712 for the 52 K/J Thermometer Operator's Manual.

1-3. SUMMARY OF CONTROLS AND MODES

For information regarding controls and modes of the 51/52, refer to the Operator's Manual provided with the instrument at the time of purchase, or turn to the Theory of Operation section in this manual.

1-4. SPECIFICATIONS

For instrument specifications, refer to the Operator's Manual provided with the instrument at the time of purchase.

Section 2
Theory of Operation

2-1. INTRODUCTION

This section of the manual describes the theory of operation of the Fluke 51 and 52 K/J Thermometers. The main features of the 51/52 are first presented at an overall functional level, followed by a detailed description using the schematic diagrams for reference. Instrument control and calibration modes are also discussed in this section. These modes may be used during performance testing and during calibration of the units.

2-2. FUNCTIONAL OVERVIEW

The Fluke 51 and 52 K/J Thermometers take nonlinear voltages from thermocouples and convert the voltages to meaningful temperature readings. These thermometers are actually microvoltmeters with additional features to compensate for the reference junction and non-linearities of thermocouples.

The heart of these instruments is an analog-to-digital converter (a/d converter) that develops a numerical representation of an analog voltage. The a/d converter (U1) works in the range of -10 mV to +55 mV. For the Fluke 52, three signals must be measured: thermocouple 1, thermocouple 2, and the signal that represents the temperature of the reference junctions. To measure the three signals, the a/d converter is connected to each of these signals one at a time. A microcomputer (U2) coordinates the switching and a/d activity performed by U1. U2 also interprets the numbers sent by the a/d converter, including reference junction compensation, linearization, and degrees Celsius and Fahrenheit conversion. U2 also monitors the instrument control buttons and drives the liquid crystal display (LCD). See Figure 2-1 for a functional overview of the 51 and 52.

2-3. DETAILED DESCRIPTION

The following information describes the 51 and 52 K/J Thermometers simultaneously. Refer to the schematic diagrams in Section 6 while reading this description.

NOTE

Reference designations used here, such as "R7,13" mean that R7 appears on both the 51 and 52 instruments, and R13 appears only on the 52 dual thermocouple instrument.

2-4. Power Supply and Switching

Vdd is the positive terminal of the battery. When the instrument is turned on (ON/OFF and U4 pin 4), Vss is regulated by an on-board regulator consisting of Q2, Q3, CR7, R31 and R32. The output of the regulator, Vss, is provided to pin 46 of U1. A "common" voltage of approximately 3.1V below Vdd is generated by pin 14 of U1. This Vdd-common voltage provides the power supply for the microcomputer (U2), the band gap reference (VR1), and the reference junction sensor (Q1). C8 provides compensation and bypassing for the Vdd-to-common regulator. U1 (pin 46) and U4 (pin 4) are the only components that use Vss. Vss-to-common changes as the battery discharges, whereas Vdd-to-common is regulated and does not change (except slightly with ambient temperature changes).

U4 and its surrounding components form two toggle flip-flops that function as instrument power switching and F/C display control button memory. Pin 4 of U4, controlled by the ON/OFF button, provides the input to the Vss regulator consisting of Q2, Q3, CR7, R31 and R32. The output of

this regulator, Vss, is provided to U1 pin 46. Pin 11 of U4 signals U1 (which in turn signals U2) indicating whether degrees Fahrenheit or Celsius is chosen by the user. The F/C flip-flop state is maintained, and cannot be changed, when the instrument is turned off. C5 and C6 provide a reverse charge to change the state of the F/C and on/off flip-flops when the buttons are depressed. C4 ensures that the F/C flip-flop does not change when the instrument is turned on or off. C13 ensures that the instrument does not turn on or off when the thermocouples experience an electrostatic discharge.

R23 and R24 provide an intermediate voltage level for the multiplexed LCD drive signals.

2-5. Analog Circuitry

NOTE

In the following text, TnLO refers to either T1LO or T2LO, TnHI refers to either T1HI or T2HI, etc.

Each thermocouple connection to U1 consists of four pins (refer to the schematics and the block diagrams). TnLO ties the low side of the thermocouple to instrument common. TnHI connects the high-side thermocouple input to the positive-sensed a/d converter input. TnPU provides approximately 70 mV to a 22-MΩ pull-up resistor (R2,8) to force the a/d converter into overload if the thermocouple is open or not plugged in. R19 and R20 provide the pull-up voltage source, approximately 70 mV. The VPU input, pin 35 on U1, is connected internally to TnPU when the particular thermocouple input is being read by U1. R7,13 provide small offset voltages to the TnOS input(s) to compensate for slight errors in thermocouples being used. The range of adjustment as seen by TnOS is approximately 0.4 mV.

The TnPU, TnHI, TnLO, and TnOS pins on U1 are continuously switched signals from within U1. When U1 is commanded by U2 to read a thermocouple input, a switch on each of the four pins closes, and the thermocouple is connected to the a/d converter. When U1 is measuring another signal (i.e., the other thermocouple or the reference junction temperature sensor), U1 opens all four switches and effectively allows the thermocouple to float within a positive limit controlled by the clamp voltage (approx. 1.23V) at pin 32 of U1. Voltages greater than 1 volt that are applied between two thermocouples (Fluke 52) can cause improper instrument operation. If this voltage exceeds 60V dc or 24V ac, the instrument can be damaged. R3,9 and R4,10 provide current limit protection.

Pins 4 through 9 of precision resistor network Z1 divide down VR1 reference voltage (approximately 1.23V) and provide various stable voltages to generate Vdd-common, establish the a/d reference voltage, and form part of the reference junction temperature-sensing circuit as described below.

Q1 is thermally connected to, but electrically isolated from, the reference junction(s) at the input connector(s). The voltage across the base and emitter is about 567 mV at 25°C, and becomes smaller as temperature increases

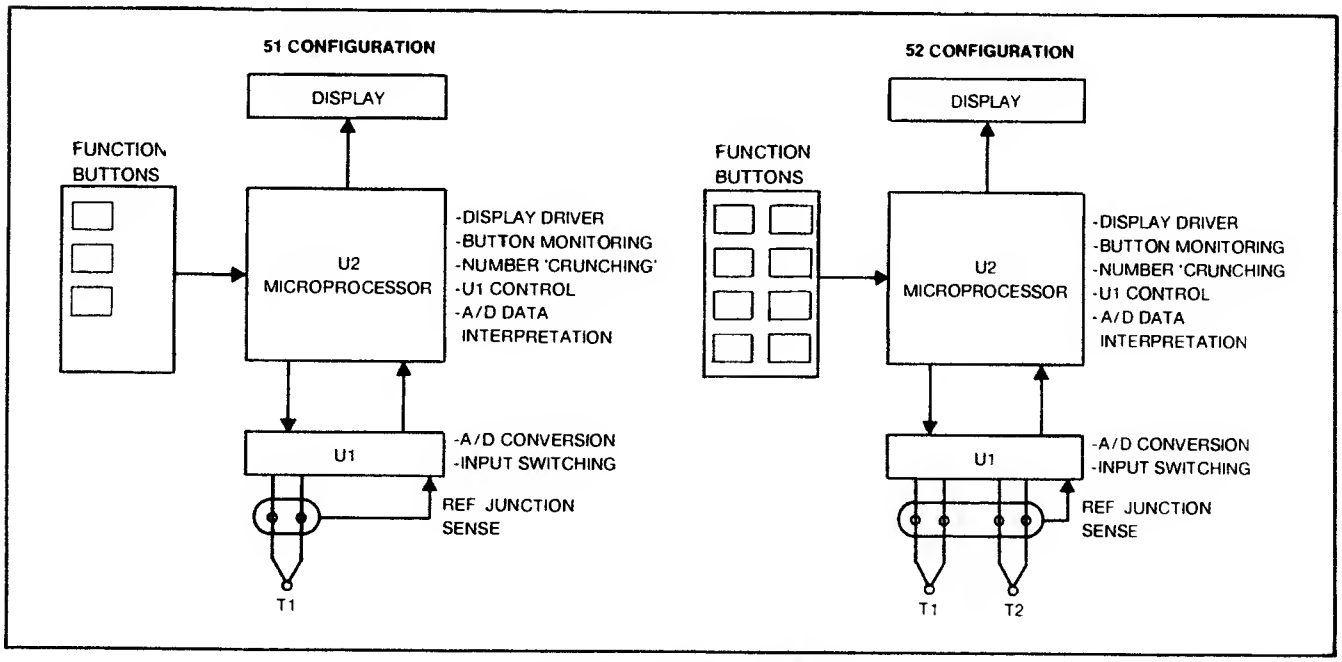

Figure 2-1. Functional Overview

(about -2.24 mV/°C). The voltage is divided down by R17 and R18 and applied to RJS LO (482 mV at 25°C and -1.90 mV/°C). Another temperature-stable voltage that matches the voltage divided by R17 and R18 when Q1 is at room temperature (482 mV at 25°C) is available from pin 6 of Z1, and is tied to RJS HI. RJS LO and RJS HI are measured by the a/d converter inputs when U2 commands U1 to read the reference junction temperature. R16 adjusts the current through Q1 for calibration of the reference junction sensing circuit.

C10 is the dual slope integrator capacitor, C11 is the auto-zero capacitor, and pins 1, 2, and 3 of Z1 form the integrate-ranging resistors.

2-6. Digital Circuitry

Crystal Y1 is the frequency-determining element for the instrument's clock source that is generated in U1. The clock signal is used by both U1 and U2 and appears on pin 56 of U1 and pin 12 of U2.

C7 resets the microcomputer when the instrument is turned on.

Connections leaving U1 called D0, D1, D2, D3 and A0, A1, A2, A3 are the data and address buses that form the communications link between U1 and U2. NRD, NWR, and NDAV are data-direction and data-availability signaling lines.

The pins labeled B0, B1, and B2 on U1 communicate operation modes to the instrument and are read just after the instrument is turned on. B0 controls display resolution and is strapped (or not strapped) to Vdd by R22, or is actuated by the elastomeric switch grid labeled TP0. B1/TP1 brings up the TC CAL (Thermocouple Calibration) mode that allows easy calibration of R7,13 initially (offset adjustments for each thermocouple channel), and allows easy calibration of R21, the a/d converter reference adjust (overall scaling adjustment). B2/TP2 brings up the RJS CAL (Reference Junction Sensor Calibration) mode and allows easy calibration of R16. The pin labeled B3 is read continuously during operation and is the F/C display control. If degrees Celsius (°C) is selected, B3 is pulled to Vdd through CR6. CR6 blocks battery drain if degrees Fahrenheit (°F) is selected when the instrument is turned OFF.

2-7. INSTRUMENT CONTROL MODES

The operation of the instrument can be altered to change default modes and access calibration functions.

2-8. Secondary Functions

The operation of the instrument may be modified by holding down the following buttons, or any combination of buttons, as the instrument is turned on. Holding down any of the buttons listed below holds all of the display segments on until the button(s) are released, which allows time to inspect the display. The full display is held on longer than the normal "self-test" display flash, indicating the unit has recognized a request for the secondary function (see Operator's Manual).

T1	Overrides resolution as selected by the absence or presence of R22.
T2	Enter Scan Mode.
HOLD	Overrides thermocouple type as selected by the absence or presence of W1.

The following is a list of strapped options.

W1	When installed, the microprocessor linearizes for K-type thermocouples. If the jumper is cut or removed, J-type linearization is used unless this action is reversed by pressing HOLD during power-on.
R22	When installed, the microprocessor causes the display to show 0.1°C or 0.2°F resolution. If the jumper is cut or removed, 1° resolution is displayed for both F and C unless this action is reversed by holding down T1 during power-on.

2-9. Calibration Modes

In the normal operating mode, the reference junction signal is measured every 13 to 20 seconds (depending on how many thermocouples are being used on the 52, and always about 13 seconds on the 51). Thermocouple samples are combined with the reference junction samples to give a display reading. It is desirable to separate the effects of these separate readings for calibration and troubleshooting purposes. Two modes are available for these purposes (TC CAL mode and RJS CAL mode).

To enter these modes, it is necessary to short the TP1 or TP2 switch grid near the ON/OFF switch grid on the printed circuit assembly (pca) with the front cover of the instrument removed. Otherwise, these modes are activated in the same manner as the secondary functions of the user button. However, the display test interval does not stay frozen while the connection is held on test points TP1 or TP2. Because of this, it is not immediately obvious that you are in a calibration mode.

CAUTION

When shorting out the switch grids, use only the soft conductive pads supplied with the service manual and called out in the required equipment list. Hard metal tools should not be used to touch the switch grid as they may damage the pca and switch contact points.

The following is a list of the test points and their functions.

TP0 Not effective if R22 is installed. Brings up high resolution for calibration purposes if R22 is not installed.

TP1 (TC CAL mode)
Offset potentiometer(s) (R7, 13) and a/d reference (R21) calibration. The thermocouple inputs are the only signals that affect the display in this mode.

In this mode, the reference junction circuit compensation is ignored; the microcomputer simulates the reference junction circuit at room temperature.

TP2 (RJS CAL mode)
Reference Junction Sensor Calibration (R16). Since the thermocouple inputs are ignored in this mode, the reference junction compensation can be calibrated without interference from the thermocouple inputs.

In this mode, the thermocouple inputs are ignored; the microcomputer simulates zero output from the thermocouples.

Section 3
Maintenance

WARNING

THESE SERVICE INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN THE OPERATOR'S MANUAL UNLESS YOU ARE QUALIFIED TO DO SO.

3-1. INTRODUCTION

This section contains maintenance information for the Fluke 51 and 52 K/J Thermometers, including performance tests, calibration, general maintenance procedures, and troubleshooting. For operator maintenance and instrument specifications, refer to the Operator's Manual.

The performance tests are recommended as a preventive maintenance tool to verify proper instrument operation. A one-year calibration cycle is recommended to maintain the specifications given in the Operator's Manual.

3-2. SERVICE INFORMATION

The Fluke 51 and 52 are warranted for a period of 3 years upon shipment of the instrument to the original purchaser. Conditions of the warranty are described on the registration card. Malfunctions that occur within the limits of the warranty will be corrected at no cost to the purchaser. For in-warranty service, ship the instrument post-paid to the Fluke Service Center nearest you. A list of service centers is included at the back of the Operator's Manual provided with the instrument at the time of purchase.

Fluke Service Centers are also available for calibration or repair of instruments that are beyond the warranty period. Upon request, a cost estimate will be provided before work is performed on instruments that are beyond the warranty period.

For application or operation assistance or information on Fluke products, call:

800-44-FLUKE (800-443-5853) in U.S.A. and Canada
31 40 723-220 in Europe
206-356-5500 from other countries

If reshipment is necessary, please use the original shipping container. If the original container is not available, be sure that adequate protection is provided to prevent damage during shipment. It is recommended that the instrument be surrounded by at least 3 inches of shock-absorbing material in the shipping container.

3-3. GENERAL MAINTENANCE

3-4. Instrument Disassembly

WARNING

TO AVOID ELECTRICAL SHOCK, REMOVE THERMOCOUPLES BEFORE OPENING THE CASE, AND CLOSE THE CASE BEFORE OPERATING THE METER.

CAUTION

To avoid contaminating the pca with oil from the fingers, handle it by the edges or wear gloves. PCA contamination may not cause immediate instrument failure in controlled environments. Failures typically show up when contaminated units are operated in humid areas.

Use the following procedure for removing the pca from its case.

1. Turn the instrument off and remove the thermocouples.
2. Remove the four case screws from the bottom cover with a #2 Phillips screwdriver.
3. Turn the meter face up, grasp the top cover, and pull the top cover from the meter.
4. Remove the Phillips screw that holds the pca to the back cover.
5. The pca may now be removed from the bottom cover.

CAUTION

To prevent damage to the case, care should be taken when reassembling the unit to not over-torque the screws (6 to 7 inch pounds is sufficient).

3-5. Display Access

CAUTION

Do not handle the conductive edges of the LCD or LCD interconnects. If the edges are contaminated, clean them with alcohol.

While referring to Figure 3-1, use the following procedure to remove the LCD from the display holding bracket.

1. Remove the four Phillips screws from the back side of the pca.
2. Remove the LCD mounting bracket.
3. Insert a small screwdriver under the edges of the display holding bracket, and gently pry the bracket loose from the snaps.
4. Turn the bracket upside down to remove the LCD.
5. Before installing a new LCD, make sure that all connector contact points are clean.

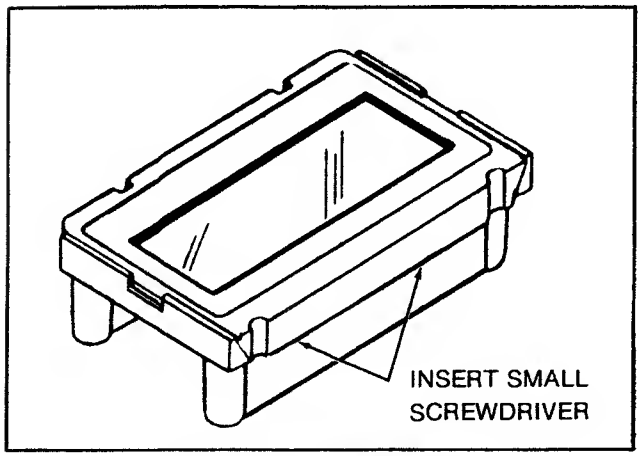

Figure 3-1. Display Assembly

3-6. Cleaning

CAUTION

To avoid damaging the meter, do not use aromatic hydrocarbons or chlorinated solvents for cleaning. These solutions will react with the plastics used in the instrument.

Do not allow the liquid crystal display to get wet. Remove the display assembly before washing the pca, and do not install until the pca is completely dry.

Do not use detergent of any kind for cleaning the pca.

Avoid removal of lubrication from the thermocouple connectors when cleaning the pca.

To relubricate the thermocouple connectors, slide the white isothermal block up and off the metal connectors. Apply a conservative amount of Amoco Rykon® PN 344572, Premium Grease, type EP-2, on the side of the connectors nearest the battery as shown in Figure 3-2.

Clean the instrument case with a mild detergent and water.

The pca may be washed with isopropyl alcohol or deionized water and a soft brush. Remove the display assembly before washing. Dry with clean dry air at low pressure and then bake at 50° C for 24 hours.

3-7. PERFORMANCE TEST

The following procedure refers to the Fluke 51 or 52 instruments as the Unit Under Test (UUT).

Performance tests are recommended for incoming inspection, periodic maintenance, and for verifying the specifications in the Operator's Manual. If the instrument fails any part of the test, calibration and/or repair is indicated.

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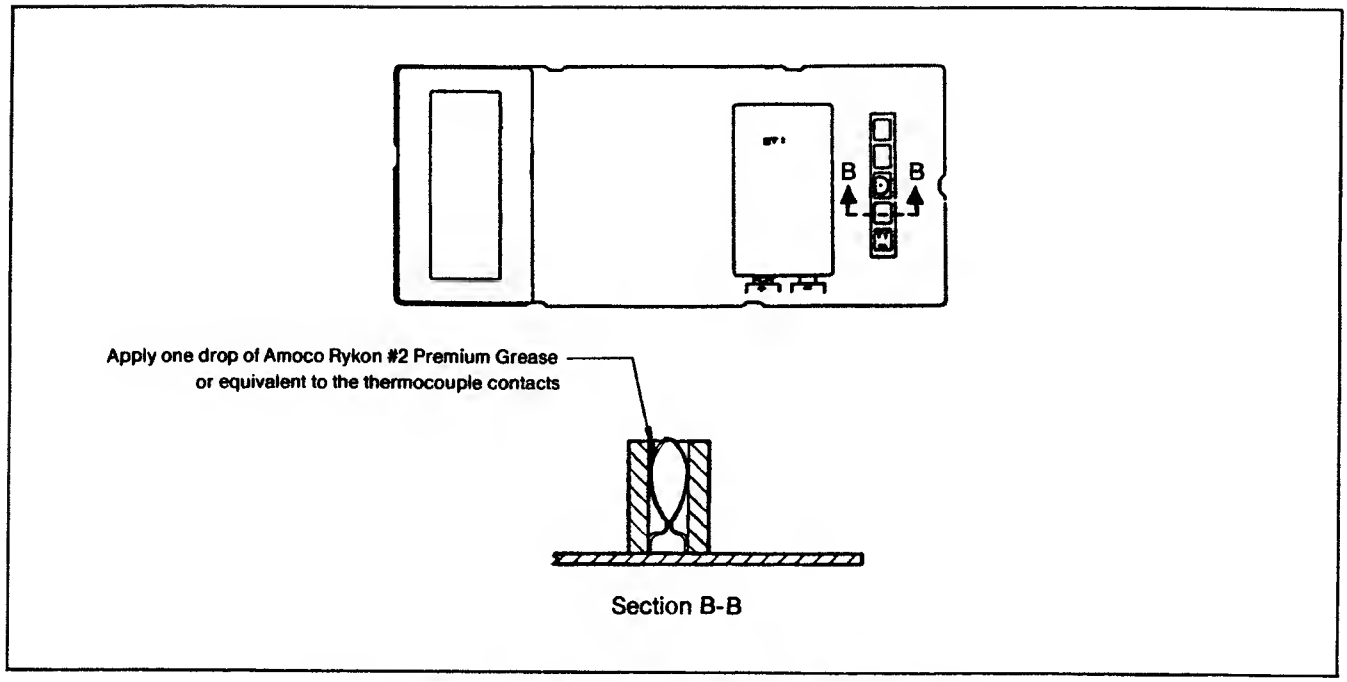


Figure 3-2. Lubricating the Thermocouple Connectors

3-8. Initial Procedure

Use the following procedure to prepare the UUT before beginning the Performance Tests or Calibration Procedures.

1. Allow the UUT to stabilize to room temperature, 23°C ± 5°C (73°F ± 9°F).
2. Check the battery and replace it if necessary.

3-9. Display Test

Turn the instrument on while continuously pressing the HOLD button. Check that all the display segments come on as shown in Figure 3-3. The entire display stays on as long as the HOLD button is pressed.

NOTE

Since pressing the HOLD button during power-up activates one of the instruments secondary functions (see Secondary Functions in Section 2-8), take care to return the instrument to its normal function (if required).

3-10. WIDE RANGE PERFORMANCE TEST PROCEDURE

The performance test listed here verifies instrument performance to its specifications. This test may be used for initial acceptance, for verifying calibration, or as an aid in troubleshooting. If the thermometer fails to meet

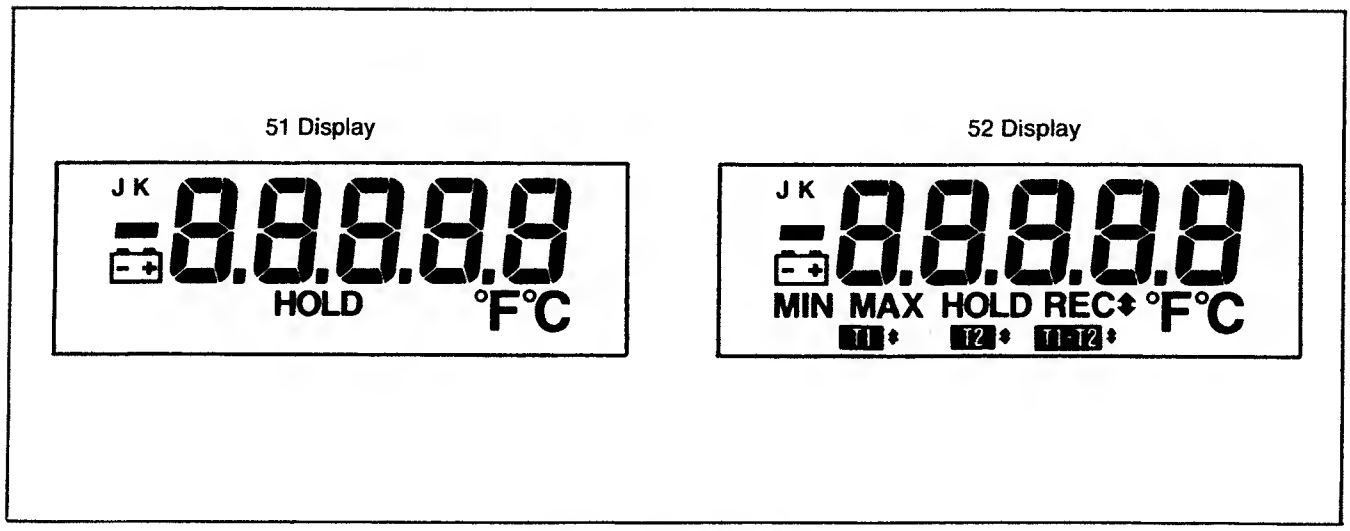


Figure 3-3. Display Test

specifications in this test, the calibration adjustment procedure or troubleshooting should be performed as determined by qualified personnel.

Test equipment required for the performance test and calibration is listed in Table 3-1. If the recommended equipment is not available, instruments with equivalent specifications may be used. The test should be conducted with an ambient temperature of 23°C ± 5°C (73°F ± 9°F).

3-11. Ice Bath Construction

To begin the Performance Test, first construct an ice bath using the following steps.

1. Prepare a Dewar Flask by drilling two holes in its cap to accept the thermometer and thermocouple wires, or use a standard laboratory cork.
2. Fill the Dewar Flask with shaved or crushed ice made from distilled water.
3. Fill the Dewar Flask with enough distilled water so that the ice becomes slush, but do not add enough water to float the ice.

NOTE

As the ice melts, siphon off the excess water and add more ice. Allow approximately 5 to 10 minutes for the water to drop back to the freezing point.

4. Replace the Dewar Flask cap or cork, and insert thermocouple wires as shown in Figure 3-4.

3-12. Ice Bath Test

Use the following procedure to test the instrument. This test should be conducted on both thermocouple inputs on the 52.

1. Connect the equipment as shown in Figure 3-4.
2. Insert the Mercury Thermometer to the same depth as the thermocouple wires, verify that the Ice Bath temperature is 0.0°C ±0.3°C.
3. Short (or apply 0 mV) to the copper wires at the 5440A Calibrator.
4. Verify that the UUT reads 0.0°C ±0.4°C.

Table 3-1. Recommended Test Equipment

TEST EQUIPMENT	REQUIRED CHARACTERISTICS	RECOMMENDED MODEL
DMM	DC Voltage Accuracy: 0.5%	Fluke model 8060A
Temperature Probe	Accuracy: Certified to ±0.2°C ambient	Fluke Model 80T-150U
DC Voltage Calibrator	Output Voltage 0 to 10V Accuracy: 0.002% Resolution: 10 μV	Fluke 5440A
Elastometer Switch Pad		Fluke P/N 680686
Thermocouple Connector	For K-type thermocouple	Fluke 80CK-M
Thermocouple Wire (K or J Type)		Omega
Dewar Flask/Cap	1-pint capacity	Thermos
Mercury Thermometer (either °C or °F)	0.02°C resolution 0.05°F resolution	Princo Model ASTM56C Princo Model ASTM56F

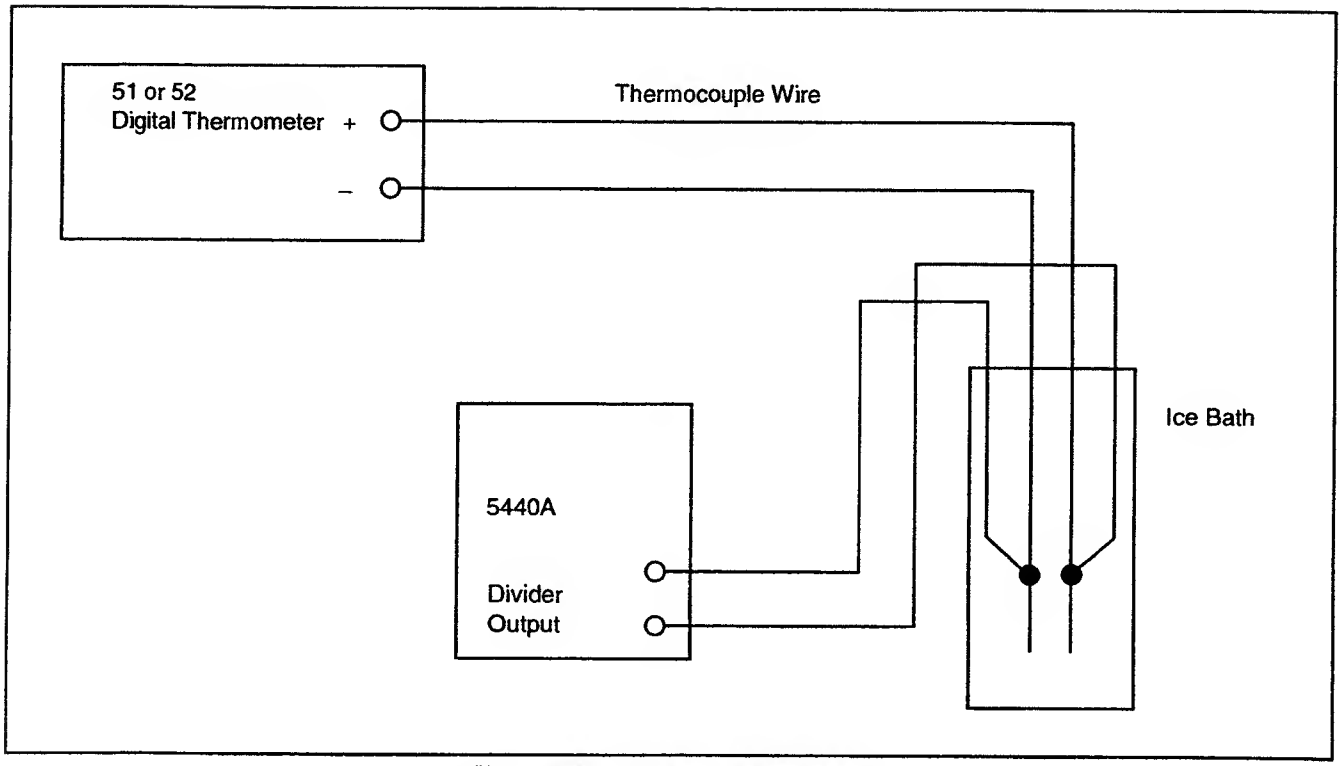


Figure 3-4. Equipment Connections

Table 3-2. Performance Test Values

THERMOCOUPLE TYPE	INPUT VOLTAGE (mV DC)	DISPLAY READING	
		DEGREES C	DEGREES F
K	-5.587	-182.0 ±(0.9)	-295.6 ±(1.6)
K	-3.211	-89.0 ±(0.8)	-128.2 ±(1.4)
K	21.919	530.0 ±(1.2)	986.0 ±(2.3)
K	54.297	1355.0 ±(2.1)	2471.0 ±(3.8)
J	-7.824	-197.0 ±(1.0)	-322.6 ±(1.7)
J	13.997	258.0 ±(1.1)	496.4 ±(1.9)
J	39.442	705.0 ±(1.5)	1301.0 ±(2.7)

If this test fails, reposition the thermocouple wires and Mercury Thermometer in the Ice Bath and repeat Step 2-4. If the test continues to fail then perform the Calibration Procedure, earlier in this section.

5. Remove the short applied in step 3.

6. Using Table 3-2 (for the corresponding thermocouple type), obtain a divided output from the 5440A equal to the first value of the "Input Voltage (mVDC)" column, and verify that the UUT reads within the limits specified.

7. Repeat step 2 for the remaining voltages in the "Input Voltage (mVDC)" column.

8. Disconnect the thermocouple from the input terminals. This completes the Ice Bath Test.

3-13. CALIBRATION PROCEDURE

The following procedure refers to the Fluke 51 or 52 instruments as the Unit Under Test (UUT).

CAUTION

When you are directed to short a switch grid below, use only the elastomeric switch pad that is supplied, as pca damage could occur if a hard tool is used.

Wire the Thermocouple Connector to the 5440A with a length of ordinary 22-gauge wire. Polarity is important, so connect the positive side to the narrow thermocouple blade and the negative side to the wide blade. When using this connector with the UUT case top removed, make sure that the wide blade is oriented the same as the case top would normally allow. Connect the equipment as shown in Figure 3-5.

3-14. Instrument Calibration

Use the following procedure to calibrate the 51 and 52 K/J Thermometers.

1. Turn UUT off and remove the top case leaving the pca in the bottom case.

2. Simultaneously short the TP1 grid and turn on the UUT by shorting the ON/OFF switch grid. Hold the elastomeric switch pad on TP1 for at least 3 seconds after turn on. This puts the UUT into the Thermocouple Calibration mode.

3. Allow the UUT to stabilize at room temperature, 23°C ±5°C (73°F ±9°F).

4. Select °C mode. Select T1 if the UUT is a Fluke 52.

5. Adjust the 5440A for 0.00000V. Connect the 5440A divider output to the TP1 input.

6. Allow the meter reading to settle and then adjust the T1 offset adjustment (R7) for a display reading of 25.2°C ±0.1°C.

Skip the next two steps if you are calibrating the Fluke 51.

7. Leave the 5440A adjusted for 0.00000V. Connect the 5440A divider output to the T2 input and select the T2 function.

8. Allow the reading to settle and adjust the T2 offset adjustment (R13) for a display reading of 25.2°C ±0.1°C.

9. Adjust the 5440A for 53.807 mV output (5.3807V on the 343A).

10. Allow the reading to settle and adjust (R21) for a display reading of +1370.0°C ±0.4°C.

11. Disconnect the UUT from the 5440A. Power down the UUT by shorting the ON/OFF switch grid.

12. With an elastomeric switch pad in both hands, use the left one to short out the TP2 grid, and use the right one to first turn on the instrument and then quickly short out the VIEW switch grid. Hold this position until the display is held in self-test. This puts the UUT into the Reference Junction Sensor calibration mode, and the VIEW

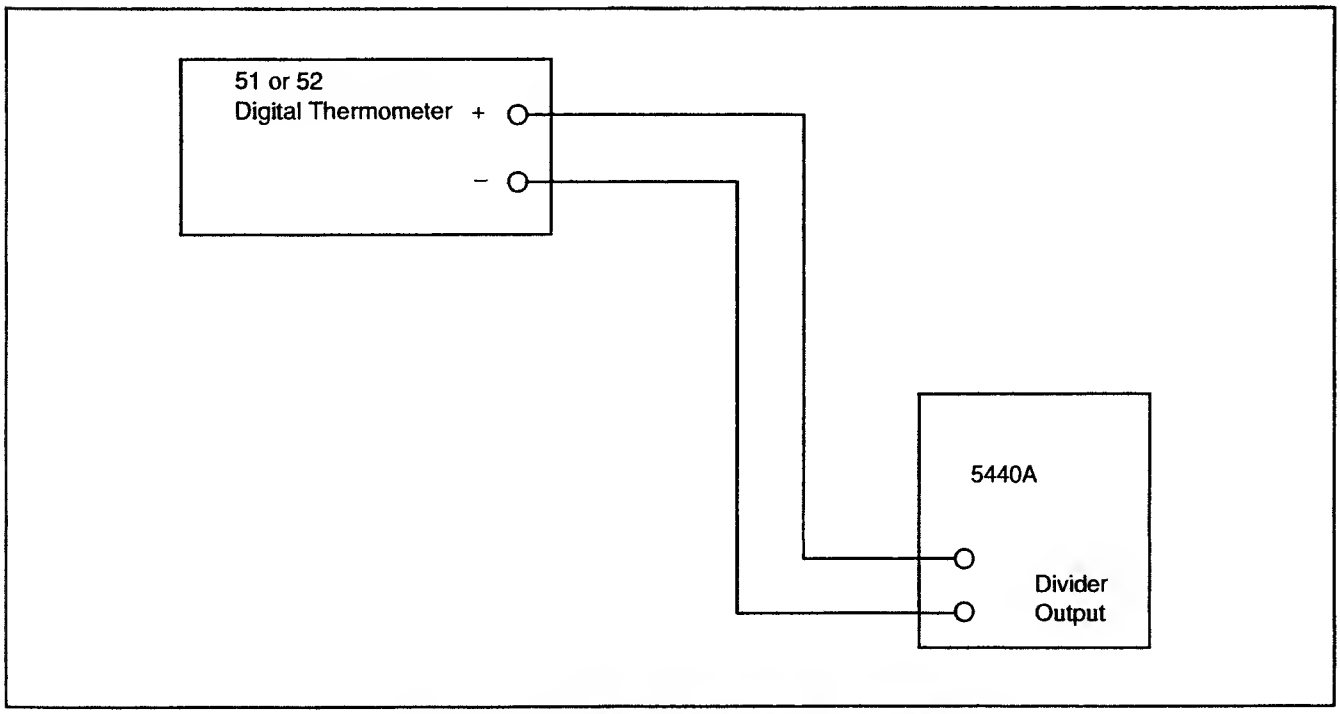


Figure 3-5. Calibration Adjustment Connections

maneuver turns off a filter so that the reading settles immediately.

13. Using the 80T-150U and the 8060A DMM, measure the reference junction transistor temperature by placing the 80T-150U probe tip against Q1, located in the middle hole of the isothermal block. Wait for the temperature reading to stabilize.

14. Adjust R16 for a temperature reading that is the same as displayed on the 8060A DMM.

15. Power down the UUT and reassemble.

The following steps optimize the UUT performance in the negative temperature range.

16. Put the UUT in normal operating mode. Normal operation can be achieved by turning the UUT OFF and then ON. No other UUT buttons should be pressed during the power cycle operation.

17. Insert a known good thermocouple in an Ice Bath (See Ice Bath Construction, earlier in this section).

18. Insert the Mercury Thermometer to the same depth as the thermocouple wires, verifying the Ice Bath temperature is 0.0°C ±0.3°C.

19. Connect the other end of the thermocouple wire to the T1 input of the UUT and allow the instrument reading to settle.

20. Slowly and in small graduations, adjust R7 (T1 OFFSET) until the UUT reading matches the Mercury Thermometer reading. Allow the UUT reading to settle and repeat the adjustment as necessary until a stable and correct reading can be attained.

21. Repeat Steps 19 and 20 for the R13 (T2 OFFSET, Fluke 52 only).

3-15. Thermocouple Input Calibration

Perform the thermocouple input calibration using the following procedure.

NOTE

This procedure optimizes the 51 or 52 for measurement with a specific thermocouple.

1. Construct an ambient temperature lag bath as shown in Figure 3-6.

2. Connect the thermocouple to the 51/52 input terminals. Select the applicable switch position (T1 or T2) and temperature scale (°C or °F). Insert the probe into a room temperature lag bath.

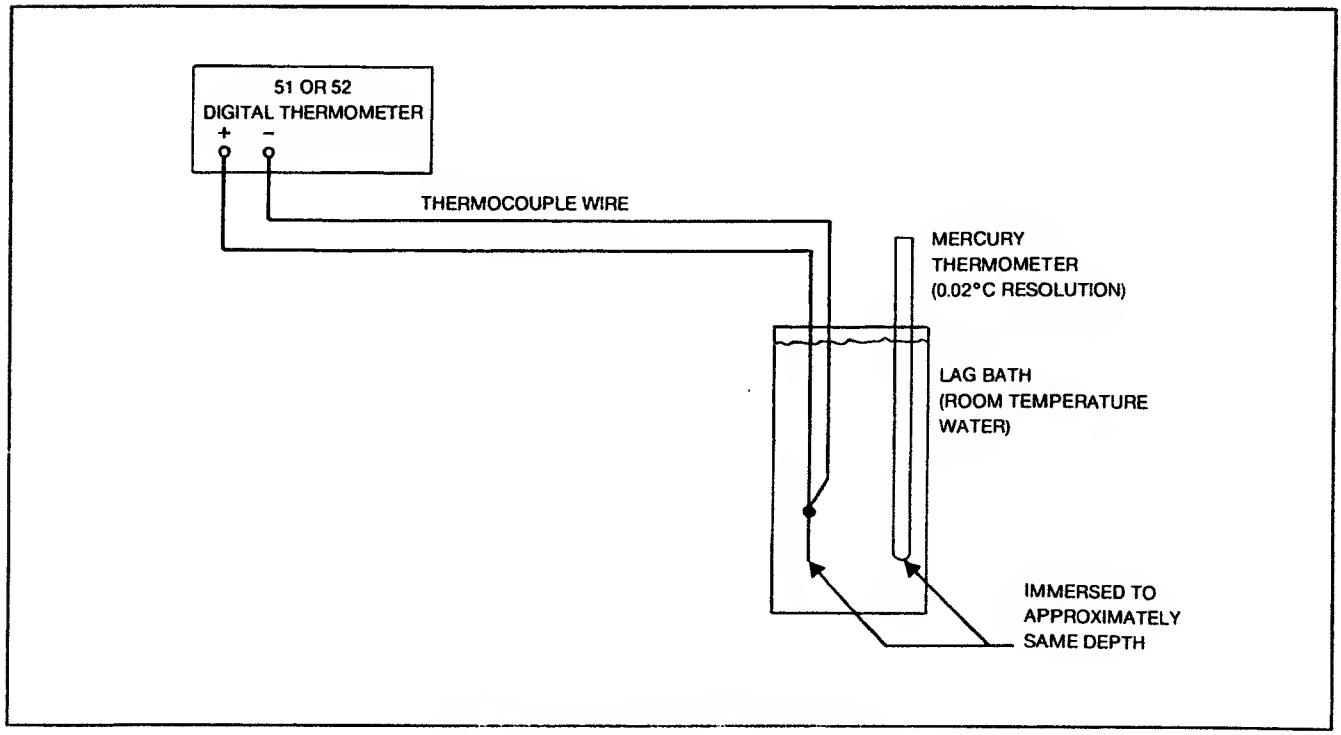


Figure 3-6. Room Temperature Lag Bath

3. Allow the system to stabilize, then adjust T1 or T2 offset adjustments for a temperature display equal to the reading of the lag bath reference thermometer.

4. Calibration of the 51/52 is complete. Disconnect all test equipment from the instrument.

3-16. TROUBLESHOOTING

CAUTION

Static discharge can damage CMOS components U1, U2, and U4. Follow the handling precautions given previously for static-sensitive components. Never remove or install components without first disconnecting all inputs to the instrument.

3-17. Introduction

If the pca must be removed from the instrument, the board should be handled by the edges or the LCD bracket. This prevents improper operation due to electrical leakage caused by body fluids and salts. After any repair operation, the pca assembly must be cleaned by the procedure outlined in Section 3-6.

When the instrument is powered on, an approximate 1-second delay occurs during the microcomputer reset interval. After that, a short (1/3 second) period occurs that forces all LCD segments to appear while an internal self-test occurs. Secondary functions are also sought by the microprocessor during the power-on sequence, such as alternate thermocouple type, alternate resolution, scan mode, TC calibration mode, and RJS calibration mode.

If the A/D converter within U1 is nonfunctional or if C10, C11 and Z1 are nonfunctional, the entire display flashes up to eight times as the instrument attempts to pass the A/D Self-Test. The instrument then exits the self-test phase and attempts to establish normal operation.

If a problem occurs, check the Operator's Manual to ensure proper operating procedures, If there is still a problem with the instrument, continue on with this section.

If U1 or U2 is defective, replacement should be left to experienced personnel. Service information is contained in Section 3-2 of this manual. For information on how to order replacement parts, refer to How To Obtain Parts in Section 4-2 of this manual. To obtain shipping information refer to the list of Fluke Service Centers in the Operator's Manual provided with the instrument a the time of purchase.

3-18. Fault Diagnosis Guide

A fault guide for the 51 and 52 K/J Thermometers is given in Table 3-3. This guide can be helpful in isolating troubles to a component area. Unless otherwise specified, make all voltage measurements with respect to instrument common. Common is generated by U1 at pin 14 (COM).

3-19. Using Calibration Modes for Troubleshooting

In the normal operating mode, the instrument obtains a reading from the combinations of the reference junction signal and the thermocouple signals. However, when troubleshooting, sections of the circuitry can be isolated.

Use TP1 to enter the TC CAL mode to eliminate the effect of the reference junction signal on the reading. In this mode, the reference junction compensation circuit is ignored; the microcomputer simulates the reference junction circuit as it would be at room temperature.

An example of the use of this mode is when the instrument displays an error indication (as shown in Figure 3-7) for T1, T2, and T1-T2. This may imply that the instrument is outside the allowable ambient operating temperature window (just below 0°C to just above 50°C). However, this display around room temperature either indicates all thermocouples are open or the reference junction circuit is malfunctioning. If the TC CAL mode is selected and the readings are roughly correct and responsive to changes in thermocouple temperature, then the reference junction circuit may be malfunctioning.

Use TP2 to enter the RJS CAL mode to eliminate the effect of the thermocouple signals. This mode samples the reference junction more often than normal, which shortens the time between readings to show the immediate effect of an adjustment (normally up to 20 seconds).

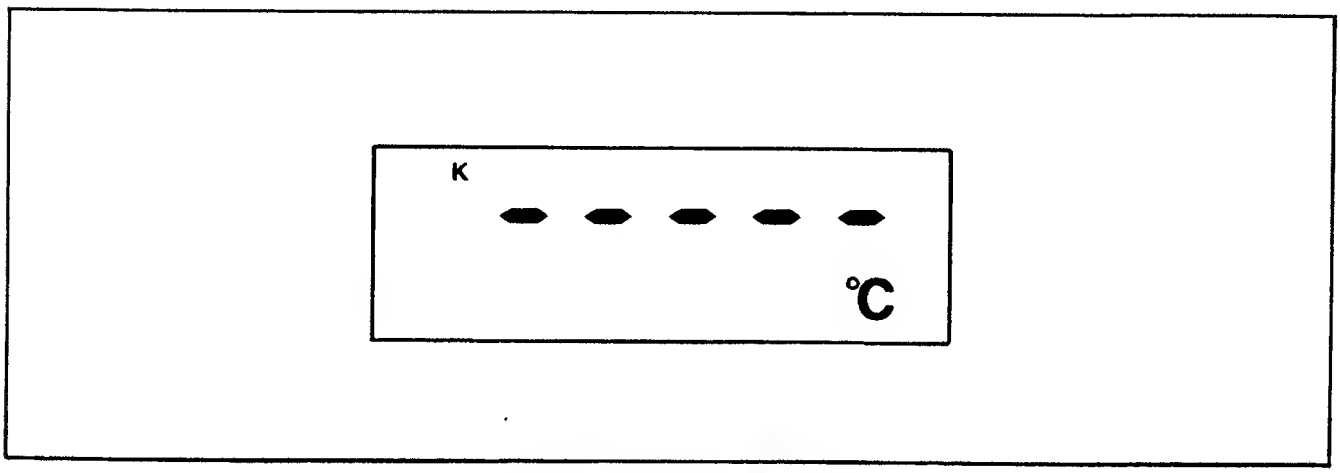


Figure 3-7. Error Indication

Table 3-3. Fault Guide

SYMPTOM	POSSIBLE CAUSE	ACTION
No display; unit fails to turn on	Dead battery.	Make sure CR5 is not shorted and that CR6 is not leaky.
	U1 not generating Vcom.	Check (+) side of battery relative to common for approximately 3.1V at room temperature (common appears on the grid pattern under the battery, VR1, pin 14, 15, and 16 of U1, etc.)
	U4 defective.	Check to see if U4 is operating; pin 4 of U4 should toggle as pin 8 is momentarily shorted to the juncture of C6, R26. Also check C6, R26, and R27.
Absent or dim and inactive display	Very low battery (the battery symbol should be visible on the display).	Replace the battery.
	No clock.	Check for approximately 32768 Hz, 3V peak-to-peak square-wave on U2 pin 12. If no signal is found, look for evidence of 32768 Hz on pin 54 of U1 and a lower level signal on pin 52 of U1. Also check U1, Y1, or C3.
Some segments are missing on the display	Contamination of LCD interconnects at pca or LCD (U3).	Look for debris trapped under elastomeric interconnect. Clean as described in Section 3-6.
	Defective LCD.	Replace the LCD.
	Defective U2.	Check for activity on U2 output strobes to the LCD.
	Damaged LCD interconnect.	Examine interconnect and contacts for contaminants. Clean per Section 3-6.
Inaccurate readings	Damaged or open thermocouple.	Replace the thermocouple.
	See if the wrong thermocouple type is installed or selected. Also see if the extension wire is of the proper thermocouple type.	Refer to Table 1 in the Operator's Manual that describes how to identify thermocouple type and wire polarity.
	The thermocouple is installed backwards. If the measurement junction and the instrument are both at the same temperature, the reading appears to be correct. However, if the measurement junction is then heated, the meter shows a colder reading.	Refer to Table 1 in the Operator's Manual that describes how to identify thermocouple type and wire polarity.
	Offset controls are misadjusted.	Recalibrate per Thermocouple Input Calibration in Section 3-15.

Table 3-3. Fault Guide (cont)

SYMPTOM	POSSIBLE CAUSE	ACTION
Inaccurate readings(cont)	Low battery (the low-battery annunciator should be on).	Replace the battery.
	Instrument is out of calibration.	Execute calibration procedure in Section 3-13.
	U1, VR1, Q1, or Z1 is defective.	Make the following measurements with a Fluke 8060A in the Hi-Z 2V DC range. All voltages are with respect to pin 4 of Z1 (instrument common). With reference junction sensor calibrated, the base of Q1 should be 567 mV at 25°C. If VR1 is operating properly, pin 9 of Z1 should be 1.23V (±0.03V). With R21 calibrated, pin 7 of Z1 should be 1.00V, pin 6 should be 482 mV ±3 mV, and pin 5 should be 170 mV ±1 mV.
	PCA contaminated around U1 and/or thermocouple input area.	Clean per Section 3-6.
Noisy or erratic readings	Exceeds common mode voltage specifications.	Check to ensure that the common mode voltage on any thermocouple is not beyond specification for the instrument. Use isolated thermocouples where the possibility of voltage differences between T1 and T2 (for the 52) is greater than 1 volt (see specifications in the Operator's Manual).
	The thermocouple may be damaged.	Check the welded measurement junction (bead) on the thermocouple. Also check all connector hardware.
	Offset potentiometers R7 and R13 are worn or defective.	Set up the 51/52 per Section 3-15 and rotate R7 and R13 to see if the display shows erratic readings.
	High level electromagnetic field possibly caused by a radio transmitter nearby.	Eliminate the suspected source and allow at least 20 seconds for the instrument to recover. C1, C2, and C12 alleviate disturbances from such EMI sources.
	Battery is very low.	Replace the battery.
	U1, VR1, C10, C11, or Z1 is defective.	Substitute parts.
	PCA contaminated around U1 and/or thermocouple input area.	Clean per Section 3-6.
	R3,9; R4,10; or R5,11 input-protection resistors damaged.	Check resistance values, replace if necessary.
	Pull-up resistor open (R2,8) and thermocouple is not plugged in or is open.	Check resistance values, replace if necessary.

Table 3-3. Fault Guide (cont)

SYMPTOM	POSSIBLE CAUSE	ACTION
No action from F/C button	U4 defective.	Pin 11 of U4 should toggle as pin 1 is shorted to the juncture of R25-C5. The purpose of C4 is to ensure that the F/C flip-flop remains in the same state when the instrument is powered on and off.
	Debris on switch grid.	Clean per Section 3-6.
	U1 defective.	Replace U1.
	CR6 open.	Replace CR6.
Short battery life	High storage temperature. Batteries tend to self-discharge more rapidly when stored at elevated temperature.	If high temperature storage is expected, use an alkaline-type battery, which exhibits longer shelf life than the carbon zinc type.
	With the instrument ON, battery drain is approximately 350 μA $\pm$50 μA at room temperature.	Check U1 and U2 current drain.
	With the instrument OFF, battery drain is greater than 5 μA at room temperature.	Check U4, CR5, and CR6 for leakage.

Section 4
List of Replacement Parts

TABLE OF CONTENTS

4-1. INTRODUCTION

This section contains an illustrated list of replaceable parts for the 51 and 52 K/J Thermometers. Parts are listed by assembly; alphabetized by reference designator. Each assembly is accompanied by an illustration showing the location of each part and its reference designator. The parts lists give the following information:

- Reference designator
- An indication if the part is subject to damage by static discharge
- Description
- Fluke stock number
- Manufacturers supply code (doe-to-name list at the end of this section)
- Manufacturers part number or generic type
- Total quantity
- Any special notes (i.e., factory-selected part)

CAUTION

A * symbol indicates a device that may be damaged by static discharge.

4-2. HOW TO OBTAIN PARTS

Electrical components may be ordered directly from the manufacturer by using the manufacturers part number, or from the Fluke Corporation and its authorized representatives by using the part number under the heading FLUKE STOCK NO. In the U.S., order directly from the Fluke Parts Dept. by calling 1-800-526-4731. Parts price information is available from the Fluke Corporation or its representatives. Prices are also available in a Fluke Replacement Parts Catalog which is available on request.

In the event that the part ordered has been replaced by a new or improved part, the replacement will be accompanied by an explanatory note and installation instructions, if necessary.

To ensure prompt delivery of the correct part, include the following information when you place an order:

- Instrument model and serial number
- Part number and revision level of the pca containing the part.
- Reference designator
- Fluke stock number
- Description (as given under the DESCRIPTION heading)
- Quantity

4-3. MANUAL STATUS INFORMATION

The Manual Status Information table that precedes the parts list defines the assembly revision levels that are documented in the manual. Revision levels are printed on the component side of each pca.

4-4. NEWER INSTRUMENTS

Changes and improvements made to the instrument are identified by incrementing the revision letter marked on the affected pca. These changes are documented on a supplemental change/errata sheet which, when applicable, is included with the manual.

4-5. SERVICE CENTERS

A list of service centers is located at the end of this section.

NOTE Ni-Cd

This instrument may contain a Nickel-Cadmium battery. Do not mix with the solid waste stream. Spent batteries should be disposed of by a qualified recycler or hazardous materials handler. Contact your authorized Fluke service center for recycling information.

MANUAL STATUS INFORMATION

Ref or Option number	Assembly name	Fluke Part Number	Revision Level
A1	FLUKE 51 Main PCA	778191	J
A2	FLUKE 52 Main PCA	778209	L

Table 4-1. FLUKE 51 AND 52 FINAL ASSEMBLY
(SEE FIGURE 4-1.)

REFERENCE DESIGNATOR -A->-NUMERICS---->	S	DESCRIPTION	FLUKE STOCK --NO--	MFRS SPLY -CODE-	MANUFACTURERS PART NUMBER -OR GENERIC TYPE-----	TOT QTY-	NOTE -E-
A 1	*	FLUKE 51 MAIN PCB	778191	89536	778191	1	
A 1	*	FLUKE 52 MAIN PCB	778209	89536	778209	1	
BT 1		BATTERY,9V,0-15MA	696534	59717	216	1	
H 1		SCREW,PH,P,THD FORM,STL,5-14,.750	733410	89536	733410	4	
H 2		SCREW,PH,P,THD FORM,STL,4-24,.250	519116	89536	519116	1	
H 6		SCREW,PH,P,THD FORM,STL,4-14,.375	448456	91662	448456	4	
MP 1		FLUKE 51 CASETOP	753251	89536	753251	1	
MP 1		FLUKE 52 CASETOP	749515	89536	749515	1	
MP 2		FLUKE 51 CASE,BOTTOM (574798)	769000	89536	769000	1	
MP 2		FLUKE 52 CASE,BOTTOM (574798)	749523	89536	749523	1	
MP 3		SHIELD,MYLAR,BOTTOM	761924	89536	761924	1	
MP 4		FLUKE 51 SWITCH PAD,MOMENTARY	744631	89536	744631	1	
MP 4		FLUKE 52 SWITCH PAD,MOMENTARY	744623	89536	744623	1	
MP 5		SUPPORT,SWITCH	749044	89536	749044	1	
MP 6		FLUKE 51 WINDOW,LCD	753350	89536	753350	1	
MP 6		FLUKE 52 WINDOW,LCD	749531	89536	749531	1	
MP 7		SHAFT,TRIM	749556	89536	749556	1	1
MP 8		FOOT,NON-SKID	640565	89536	640565	4	
MP 9		BRACKET,LCD	646653	89536	646653	1	
MP 10		MASK,BRACKET	642090	89536	642090	1	
MP 12		BLOCK,ISOTHERMAL	745794	89536	745794	1	
MP 14		SHOCK ABSORBER	428441	89536	428441	1	
MP 15		CONN,ELASTOMERIC,LCD TO PWB,1.900 L	649632	0K392	SG	2	
MP 40		LABEL, WINDOW FLUKE-PHILIPS	844340	89536	844340	1	
TC 1, 2		T/C ASSY,K-TYPE,BEADED,MOLDED-PLUG	773135	93768	C-SK-1401-1	1	2
TM 1		FLUKE 51 OPERATOR MANUAL	769026	89536	769026	1	
TM 1		FLUKE 52 OPERATOR MANUAL	764712	89536	764712	1	
TM 2		FLUKE 51 OPERATOR,INTL MANUAL	791509	89536	791509	1	
TM 2		FLUKE 52 OPERATOR,INTL MANUAL	791517	89536	791517	1	
TM 3		PRINTED MATL,WARRANT CARD,FLUKE 51/52	784462	89536	784462	1	
U 3		FLUKE 51 LCD,5 DIGIT,TEMP,MULTIPLEXED	742205	18520	LF7208G	1	
U 3		FLUKE 52 LDC,5 DIGIT,TEMP,MULTIPLEXED	741314	89536	741314	1	

An * in 'S' column indicates a static-sensitive part.

NOTES:
1. FOR FLUKE 51, QTY = 1.
2. FOR FLUKE 51, QYT = 1 (TC1).

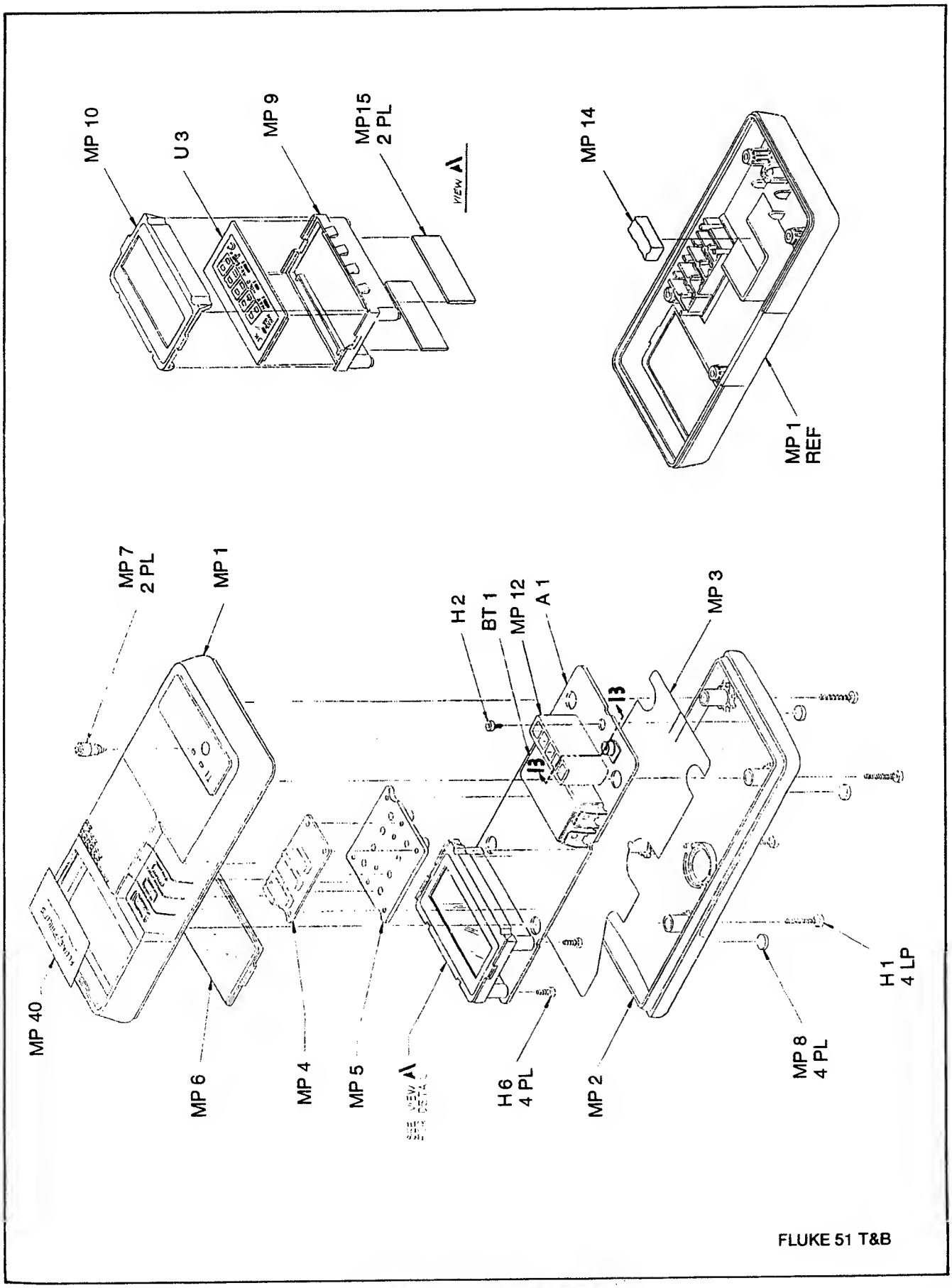


Figure 4-1. Fluke 51 Final Assembly

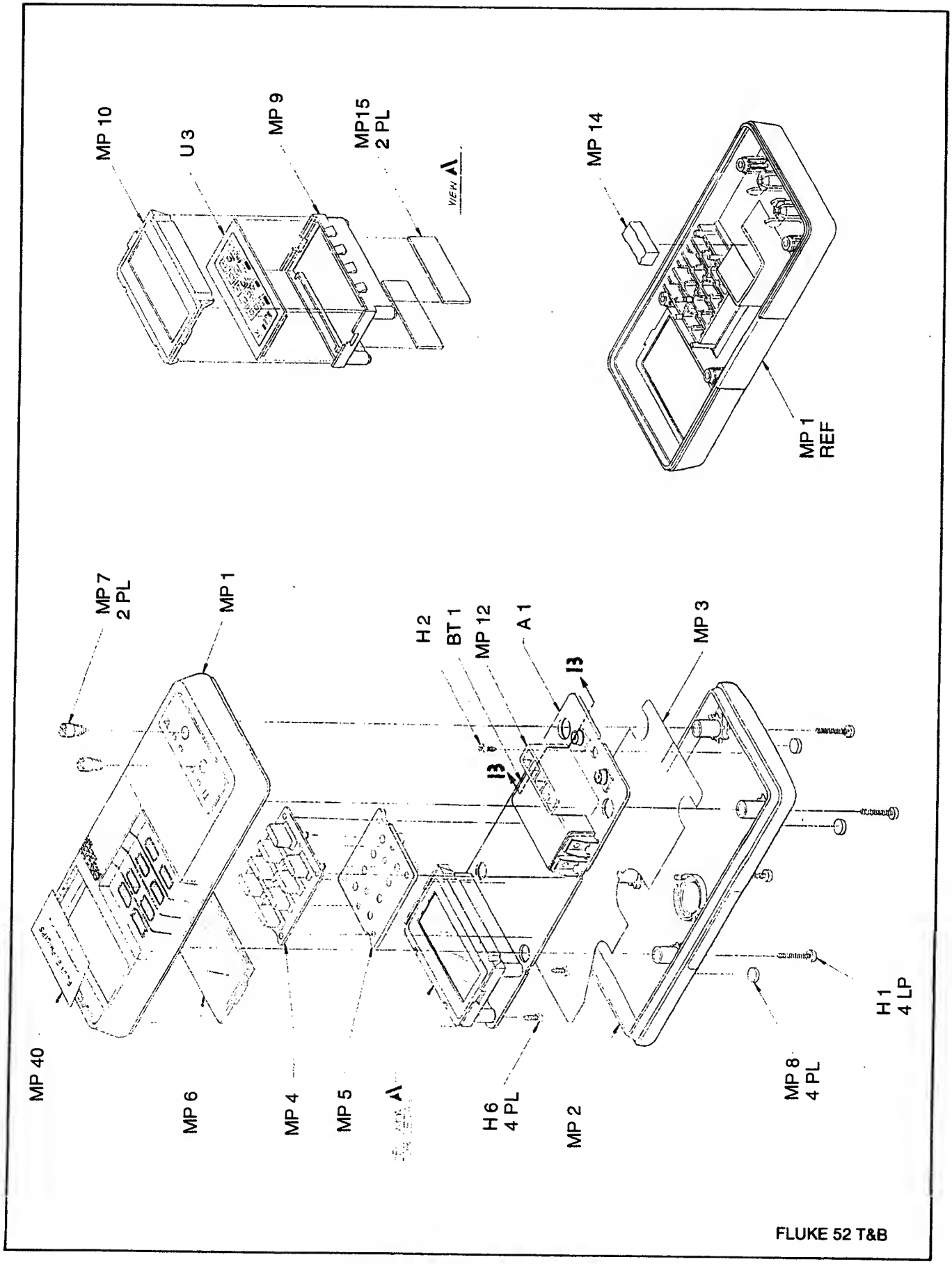


Figure 4-2. Fluke 52 Final Assembly

TABLE 4-2. A1 MAIN PCB
(SEE FIGURE 4-3.)

REFERENCE DESIGNATOR -A>-NUMERICS---->	S	DESCRIPTION	FLUKE STOCK --NO--	MFRS SPLY -CODE-	MANUFACTURERS PART NUMBER -OR GENERIC TYPE-----	TOT QTY-	NOT -E-
C 1, 2, 12		CAP,CER,4700PF,+-20%,100V,C0G	743427	04222	SR591A472MAA	3	1
C 3, 14		CAP,CER,33PF,+-5%,50V,C0G	714543	04222	SR595A330JAA	2	
C 4, 13		CAP,CER,220PF,+-20%,50V,C0G	740654	04222	SR595A221MAA	2	
C 5		CAP,CER,0.01UF,+80-20%,50V,Z5V	697284	60705	562CZ5USE051EE103M	1	
C 6		CAP,CER,0.22UF,+80-20%,50V,Z5U	733386	04222	SR595E224ZAA	1	
C 7, 9		CAP,AL,0.47UF,+-20%,50V,SOLV PROOF	769695	62643	KMA50474M4X7LL	2	
C 8		FLUKE 51 CAP,AL,2.2UF,+-20%,50V	769687	62643	KMA50T2R2M45X85LL	1	
C 8		FLUKE 52 CAP,TA,2.2UF,+-20%,16V	706804	56289	199D225X0016AE2	1	
C 10		CAP,POLYPR,0.033UF,+-10%,63V	721050	68919	MKP20333K63	1	
C 11		CAP,POLYES,0.1UF,+-10%,50V	649913	68919	MKS2104K50	1	
C 15		CAP,TA,22UF,+-20%,15V	423012	56289	199D226X0015DA2	1	
CR 1- 6	*	DIODE,SI,BV=75V,IO=150MA,500MW	659516	15238	1N4448	6	2
CR 7	*	ZENER,UNCOMP,6.2V,2%,50UA,250MW,DO-35	927392	89536	927392	1	
MP 1	*	PWB,MAIN	753244	89536	753244	1	
MP 2, 5- 7		CONTACT, THERMOCOUPLE	745802	89536	745802	4	3
MP 3		CONTACT,BATTERY	642967	89536	642967	1	
MP 4		CONTACT,BATTERY	654228	89536	654228	1	
Q 1	*	TEMPERATURE SENSOR TRANSISTOR,TAPED	761908	89536	761908	1	
Q 2	*	TRANSISTOR,SI,PNP,T092	698233	04713	2N3906	1	
Q 3	*	TRANSISTOR,SI,P-JFET,TO-92	852111	17856	J6006	1	
R 1, 20		RES,CF,51K+-5%,0.25W	747550	59124	CF1/4 513J	2	
R 2, 6, 8,		RES,CF,22M,+-5%,0.25W	757104	59124	CF1/4 226J	4	4
R 12			757104				
R 3 5, 9-		RES,CF,100K,+-5%,0.25W	658963	59124	CF1/4 104J	8	5
R 11, 22, 32			658963				
R 7, 13		RES,VAR,CP,1M,+-30%,0.2W	772335	89536	772335	2	6
R 14, 31		RES,CF,12K,+-5%,0.25W	757799	59124	CF1/4 123J	2	
R 15		RES,MF,15.4K,+-1%,0.125W,100PPM	772038	59124	MF50D1542F	1	
R 16		RES,VAR,CERM,30K,+-20%,.3W	772905	89536	772905	1	
R 17		RES,MF,100K,+-1%,0.125W,100PPM	757807	59124	MF50D1003F	1	
R 18		RES,MF,562K,+-1%,0.125W,100PPM	757815	59124	MF50D5623F	1	
R 19		RES,CF,750K,+-5%,0.25W	747543	59124	CF1/4 754J	1	
R 21		RES,VAR,CERM,500K,+-20%,.3W	747592	89536	747592	1	
R 23		RES,MF,301K,+-1%,0.125W,100PPM	655274	59124	MF50D3013F	1	
R 24		RES,MF,332K,+-1%,0.125W,100PPM	655217	59124	MF50D3323F	1	
R 25, 26		RES,CF,1M,+-5%,0.25W	649970	59124	CF1/4 105J	2	
R 27, 28		RES,CF,150K,+-5%,0.25W	758219	59124	CF1/4 154J	2	
U 1		FLUKE51/52 AP52 CHIPASSEMBLY TESTED	751552	89536	751552	1	
U 2	*	IC,CMOS,4 BIT MICROMPTR, FLUKE52-9001	741520	89536	741520	1	
U 4	*	IC,CMOS,QUAD XOR GATE	586727	04713	MC14070BCP	1	
VR 1	*	IC,1.23V,60PPM TC,BAND GAP REFERENCE	654707	27014	LM285BXZ-1.2D26Z	1	
W 1		RES JUMPER,0.02,0.25W	682575	91637	FRJ-55	1	
Y 1		CRYSTAL,32.768KHZ,+ 1%,3 X 8MM	643031	61429	NC-26-32.768KHZ	1	
Z 1		RNET,CERM,SIP,FLUKE 51 LO V DIVIDER	824144	89536	824144	1	

An * in 'S' column indicates a static-sensitive part.

NOTES:

1. FOR FLUKE 51, QTY = 2 (C1,12)
2. FOR FLUKE 51, QTY = 2 (CR5,6)
3. FOR FLUKE 51, QTY = 2 (MP2,5)
4. FOR FLUKE 51, QTY = 2 (R2,6)
5. FOR FLUKE 51, QTY = 7 (R3-5,28,29,30,32)
6. FOR FLUKE 51, QTY = 1 (R7)

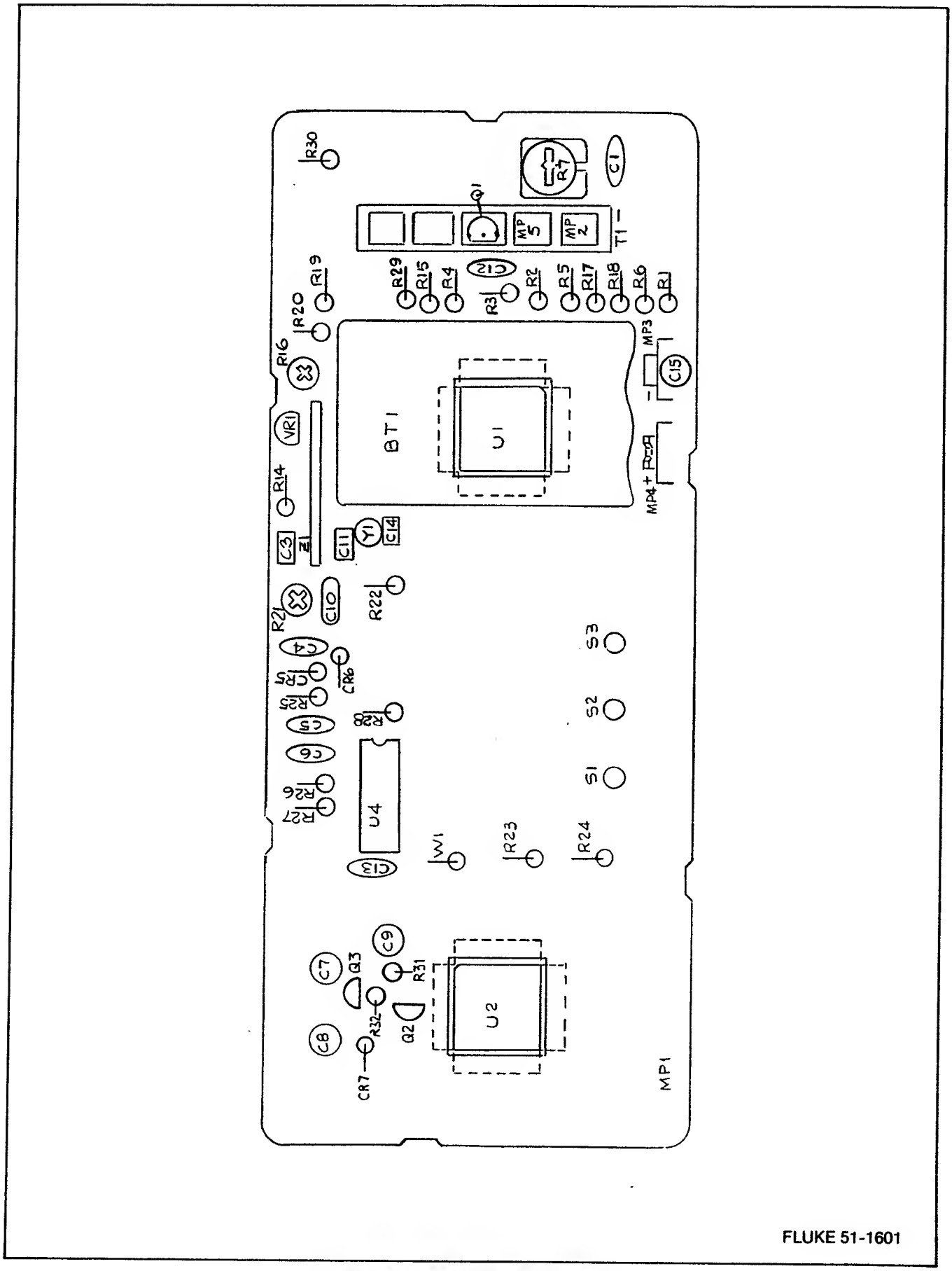
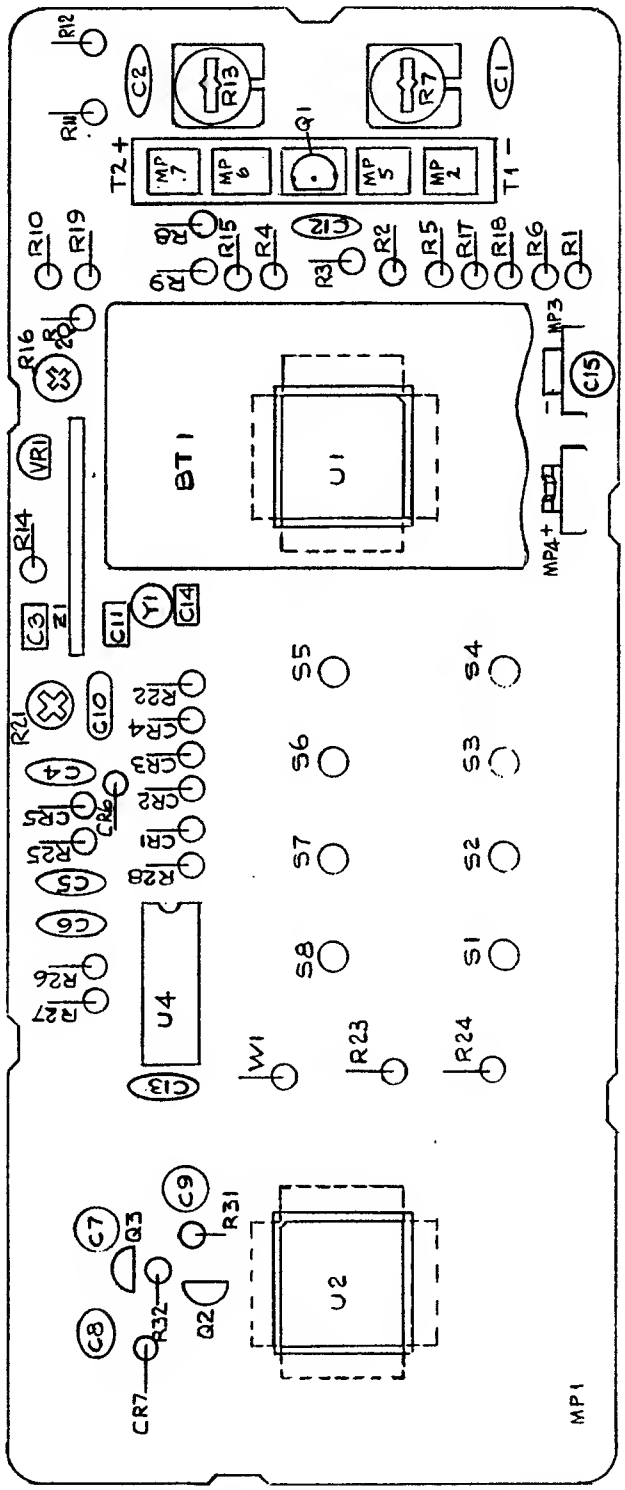


Figure 4-3. Fluke 51 A1 Main PCA



FLUKE 52-1601

Figure 4-4. Fluke 52 A1 Main PCA

Section 5
List of Abbreviations

5-1. INTRODUCTION

Table 5-1 in this section contains a list of definitions for abbreviations used in the schematic drawings for the Fluke 51 and 52 K/J Thermometers.

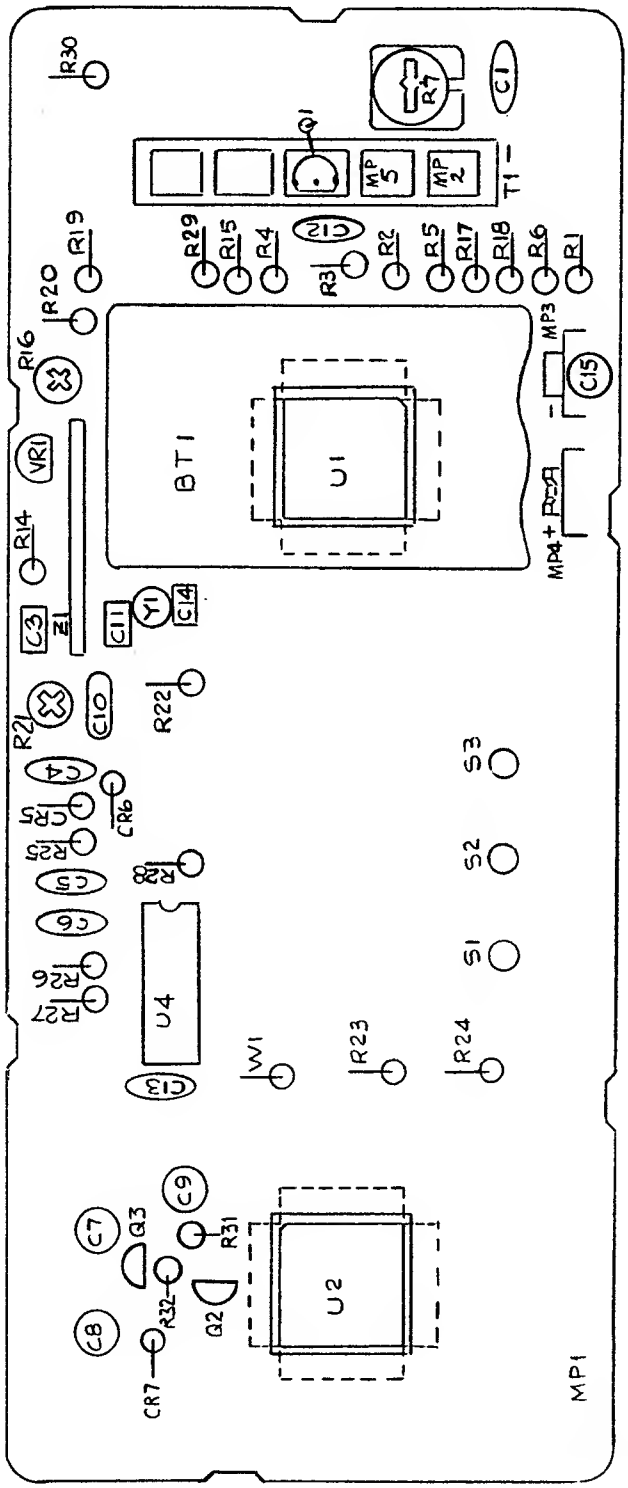
Table 5-1. Abbreviations

ABBREVIATION	DEFINITION
ACL	Auto Clear (Reset)
AZ	Auto Zero
CLAMP	Clamp Voltage Source
CLK	Clock
COM	Instrument Common
EC	Common Reference Voltage
INT	Integrator Output
K (kilo)	Multiple of 1000
K0	Buffer Output 0
K1	Buffer Output 1
M (mega)	Multiple of 1000000

Table 5-1. Abbreviations (cont)

ABBREVIATION	DEFINITION
REF+	Positive A/D Reference
REF−	Negative A/D Reference
RJS HI	Reference Junction Sense High
RJS LO	Reference Junction Sense Low
TLO	Thermocouple Low
T1HI	+ Side of Thermocouple 1
T2HI	+ Side of Thermocouple 2
T1LO	− Side of Thermocouple 1
T2LO	− Side of Thermocouple 2
T1OS	Thermocouple 1 Offset
T2OS	Thermocouple 2 Offset
T1PU	Thermocouple 1 Pull-up
T2PU	Thermocouple 2 Pull-up
VDD	Positive Supply
VM	LCD Middle Voltage
VPU	Pull-up Voltage Source
VSS	Negative Supply
XTL	Crystal Oscillator
p (pico)	Multiple of .000000000001
μ (micro)	Multiple of .000001

Section 6
Schematic Diagram



FLUKE 51-1601

Figure 6-1. Fluke 51 A1 Main PCA

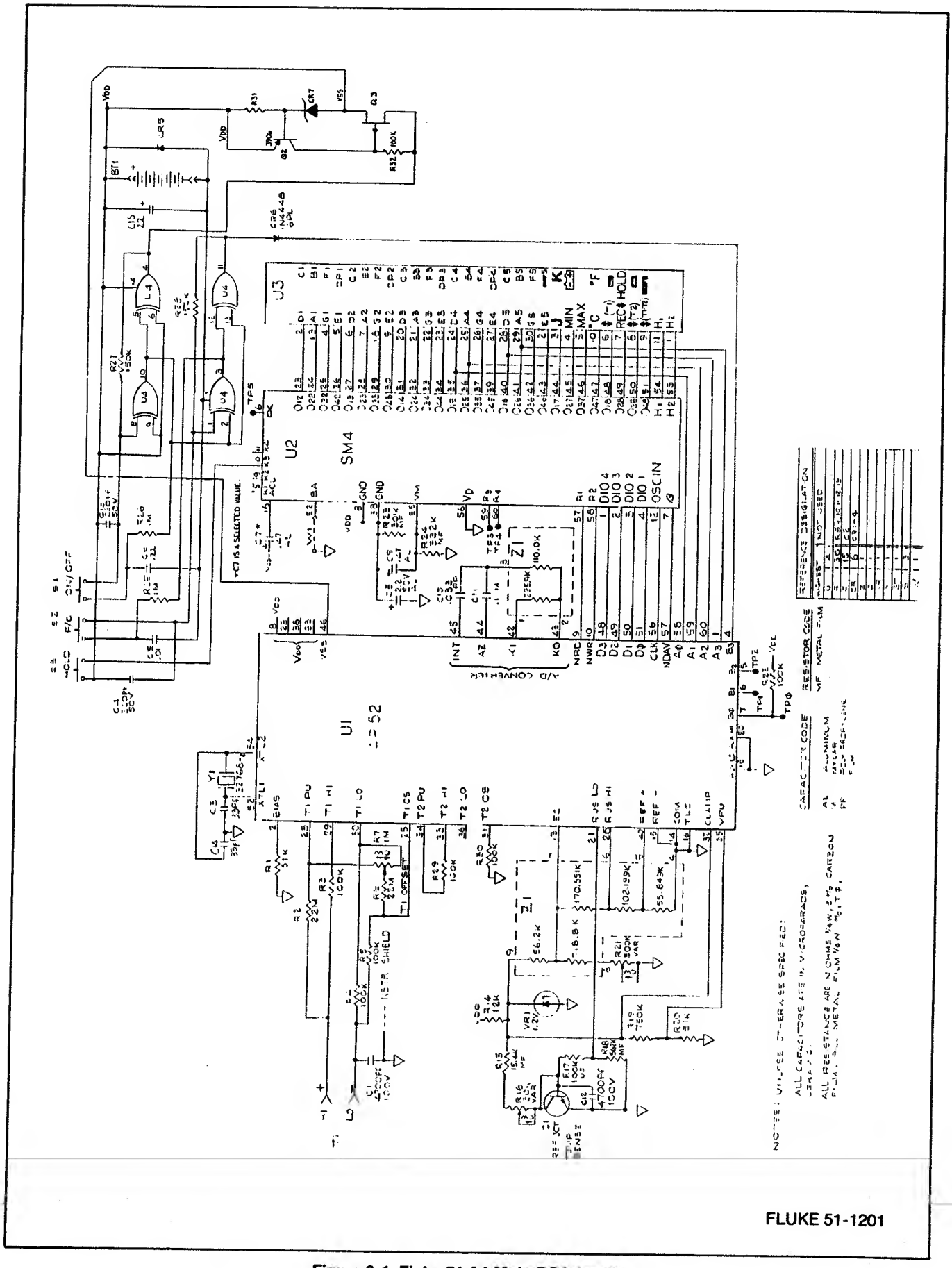
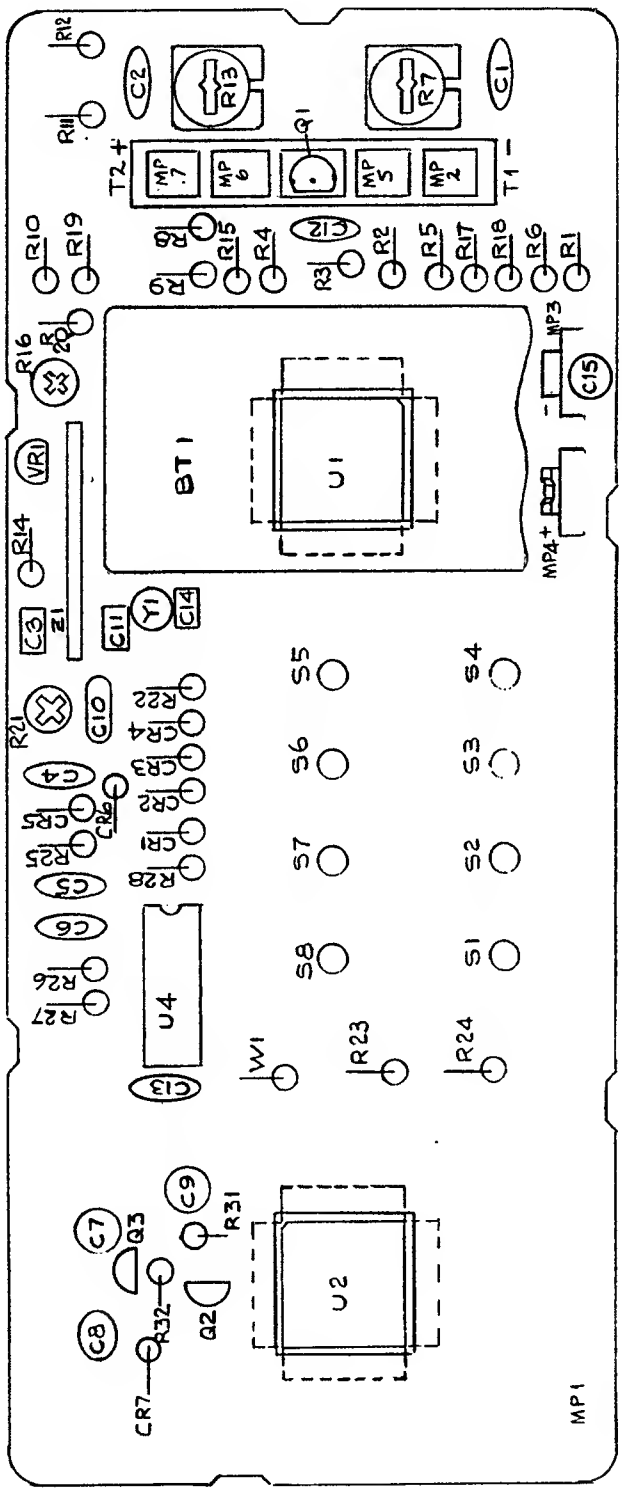


Figure 6-1. Fluke 51 A1 Main PCA (cont)



FLUKE 52-1601

Figure 6-2. Fluke 52 A1 Main PCA

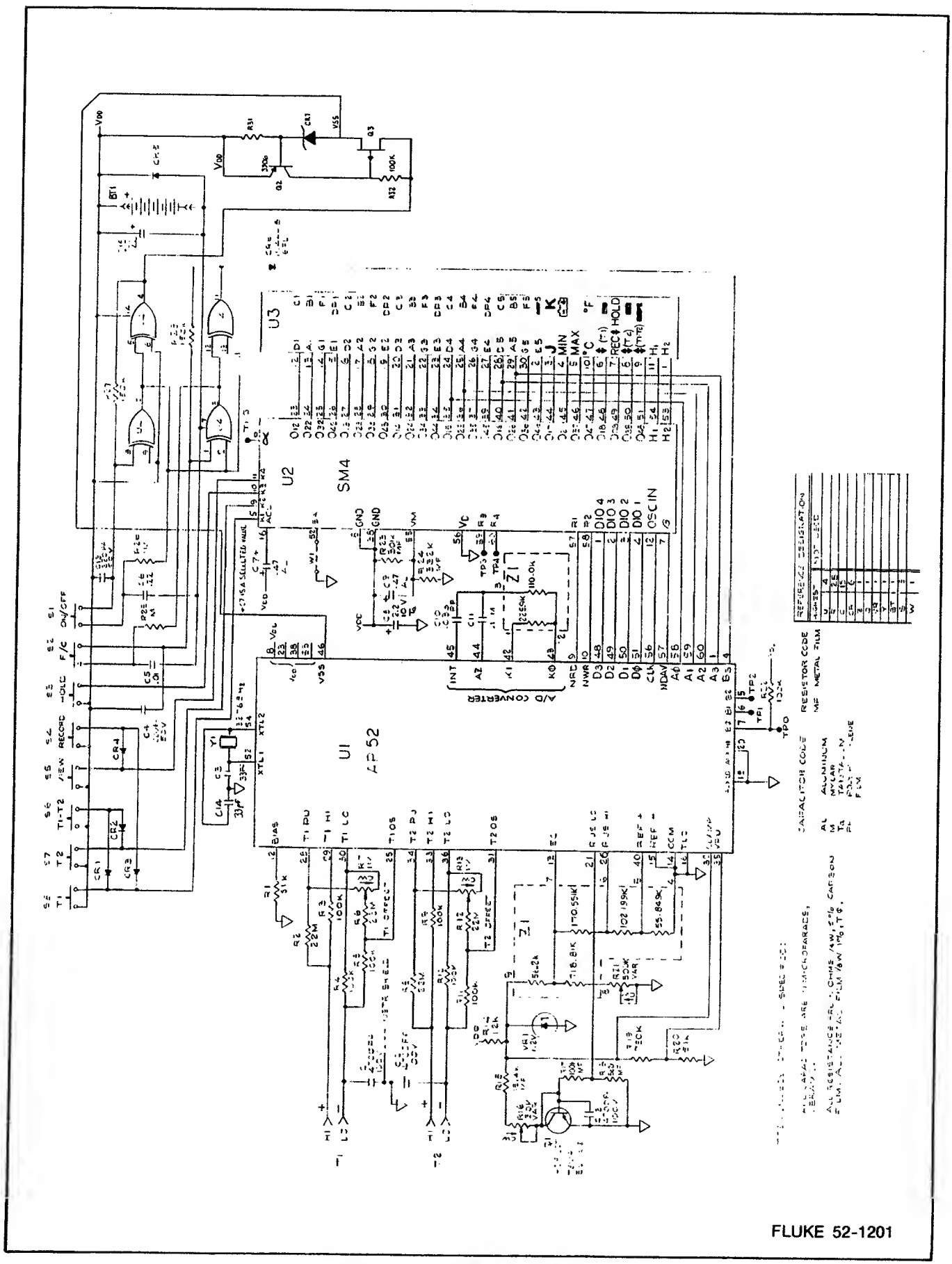
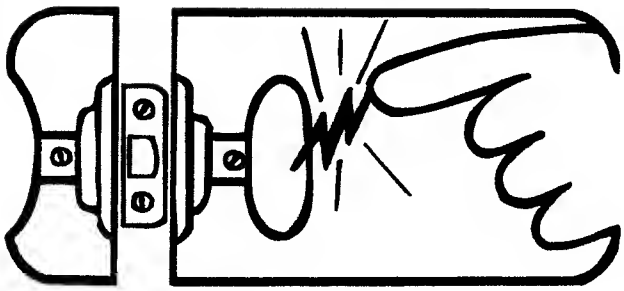


Figure 6-2. Fluke 52 A1 Main PCA (cont)

static awareness

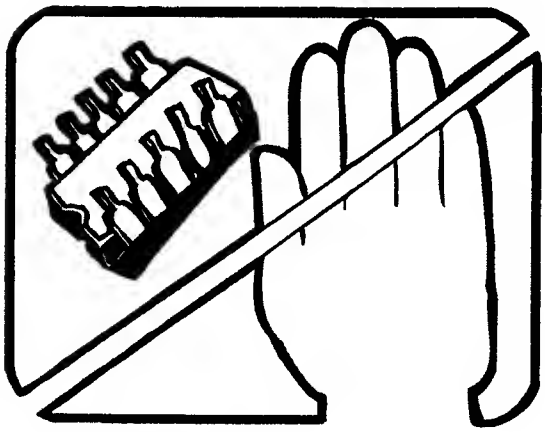
A Message From
Fluke Corporation



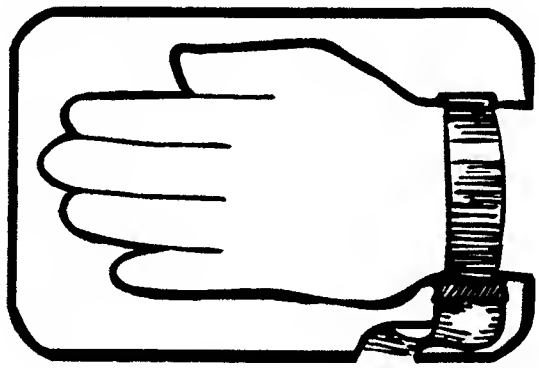
Some semiconductors and custom IC's can be damaged by electrostatic discharge during handling. This notice explains how you can minimize the chances of destroying such devices by:

1. Knowing that there is a problem.
2. Leaning the guidelines for handling them.
3. Using the procedures, packaging, and bench techniques that are recommended.

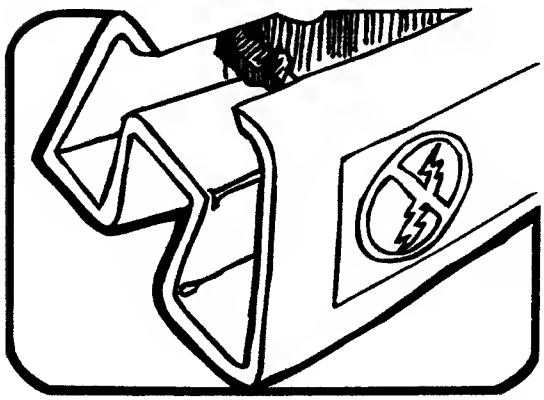
The following practices should be followed to minimize damage to S.S. (static sensitive) devices.



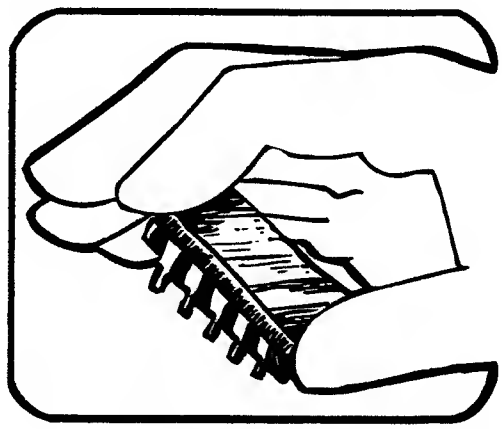
1. MINIMIZE HANDLING



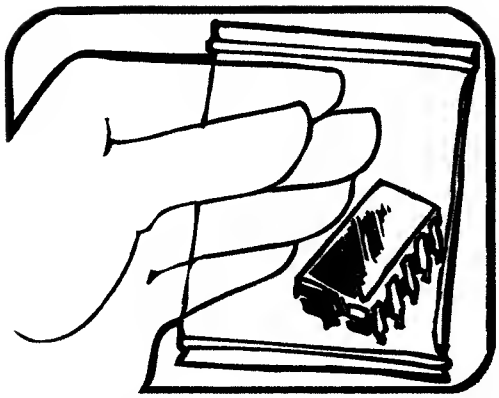
3. DISCHARGE PERSONAL STATIC BEFORE HANDLING DEVICES. USE A HIGH RESISTANCE GROUNDING WRIST STRAP.



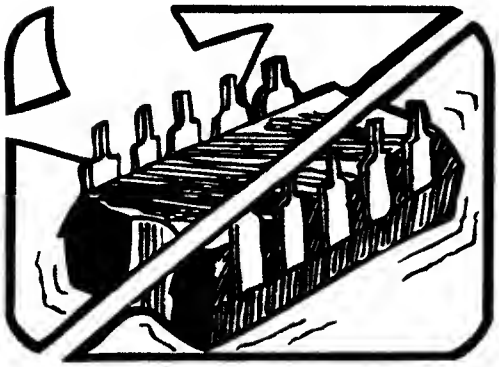
2. KEEP PARTS IN ORIGINAL CONTAINERS UNTIL READY FOR USE.



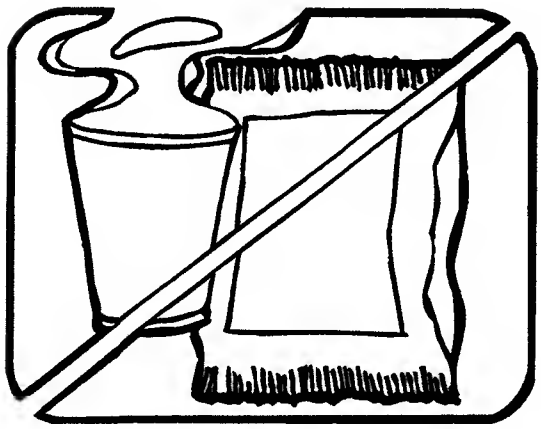
4. HANDLE S.S. DEVICES BY THE BODY.



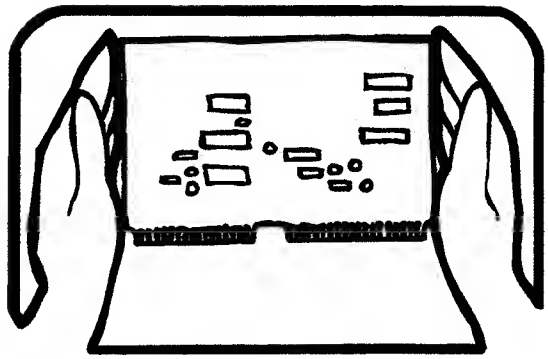
5. USE STATIC SHIELDING CONTAINERS FOR HANDLING AND TRANSPORT.



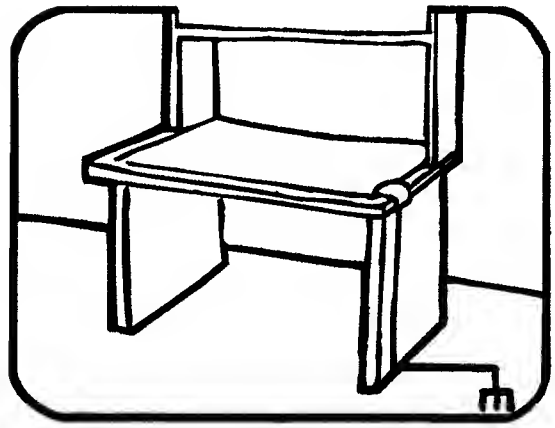
6. DO NOT SLIDE S.S. DEVICES OVER ANY SURFACE.



7. AVOID PLASTIC,VINYL AND STYROFOAM® IN WORK AREA.



8. WHEN REMOVING PLUG-IN ASSEMBLIES HANDLE ONLY BY NON-CONDUCTIVE EDGES AND NEVER TOUCH OPEN EDGE CONNECTOR EXCEPT AT STATIC-FREE WORK STATION. PLACING SHORTING STRIPS ON EDGE CONNECTOR HELPS PROTECT INSTALLED S.S. DEVICES.



9. HANDLE S.S. DEVICES ONLY AT A STATIC-FREE WORK STATION.

10. ONLY ANTI-STATIC TYPE SOLDER-SUCKERS SHOULD BE USED.

11. ONLY GROUNDED-TIP SOLDERING IRONS SHOULD BE USED.

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